Clean Water Legislation: An Economist's Perspective

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Water quality management in the United States began in 1899 with the federal Refuse Act, which was passed to prevent the dumping of refuse in waterways (see article by Moreau, this issue). Federal legislation in the 1950s provided money for water quality research and grants to cities to help build wastewater treatment facilities. The wastewater treatment plant program has improved water quality in many cases but has been unnecessarily costly for at least two reasons: secondary treatment has been required of all cities and towns regardless of ambient water conditions, and the treatment plants have often been poorly operated (Kneese, 1975).

The Water Quality Act of 1965 required states to set ambient standards for all bodies of water and to devise implementation plans that placed effluent limits on industries and municipalities that would lead to attainment of the standards. The states, however, were unprepared to design or enforce such plans, and most had little motivation to improve water quality because of the ongoing cost implications and the fear of losing industry. The enforcement procedures incorporated in the 1965 act allowed companies and towns to delay compliance indefinitely. An exception to the ineffectiveness of early efforts was the Ohio River Valley Sanitation Commission, created through an interstate agreement among the riparian states of the upper Ohio River to cut back average pollution loads and to order emergency cutbacks during low flow periods when pollutant concentrations would rise (Cleary, 1967).

The 1972 Federal Water Pollution Control Act Amendments (now commonly known as the Clean Water Act) gave the U. S. EPA the power to issue permits for major dischargers and established national emission limitations for various industry groups based on available end-of-pipe technology. States were given the power to establish ambient water standards and implementation plans, including permitting authority for all sources, subject to the minimum federal emission standards. EPA was authorized to take over those functions that states failed to perform.

In 1968, EPA's National Water Quality Inventory revealed that non-point sources of water pollution were very important. Thirty-three states indicated that non-point sources were a major problem, and 47 states listed agricultural run-off as the leading source of non-point pollution. Agriculture was reported as the primary polluter for 64 percent of below-standard river miles, 57 percent of the surface area of affected lakes, and 19 percent of polluted estuarine areas (Davidson, 1990). The current Clean Water Act exempts irrigation return flows from direct regulation, even though these flows are frequently directly identifiable from surface drainage ditches or underground tile drains. In other situations, the flows percolate through the soil and return to streams far in place and time from their application. This displacement obviously raises major conceptual and practical problems for monitoring and control.

The extent of agricultural non-point-source pollution results in part from a lack of coordination between agricultural and environmental policies. Agricultural output limitation is carried out through acreage limitation, which induces farmers to plant crops intensively with heavy applications of fertilizer and pesticides. At the same time, the federal policy of providing cheap irrigation water induces excessive applications of water that carry salts, fertilizer, and pesticides back to the stream. Rational water management must take these water quality changes into account (Howe, 1986).

Overall, large inefficiencies in the water quality program result from the lack of coordination with the policies of other sectors. Water quality and water quantity (supply) policies are established by different departments in the federal government and most state governments. Intermedia problems such as nitrate deposition and run-off into water bodies are frequently overlooked. The absence of a systems viewpoint is all too obvious.

Nonetheless, the national water program is better adapted to local and regional differences than is the air quality program because the states are allowed to set ambient water quality standards and to determine the conditions of discharge permits (subject to federal industrial standards), as well as to determine the strictness of monitoring and compliance. In this respect, the water system is both more flexible and probably more efficient than the air quality program. However, interstate water concerns are addressed only in ad hoc ways, such as the Colorado River Salinity Program of the Bureau of Reclamation, which is carried out mainly at federal expense.

Excessive Costs of the Water Quality Program

U. S. environmental management has proven to be costly in comparison with (estimated) least-cost systems. According to one fairly "soft" estimate, the cost of the current system is at least twice that of a least-cost system (Stewart, 1985). Actual air and water program costs are often several times higher than the estimated minimum attainable costs, as illustrated by the data in Table 1.

Table 1
Comparisons of CAC Water Quality Costs to Estimated Minimum Costs

Year of Study	Pollutant	Area	Ratio of Actual Cost to estimated least cost[a]
1967	Biochemical oxygen demand	Delaware Estuary 86-mile reach	3.13 1.62 1.43
1980	Biochemical oxygen demand	20-mile segment of lower Fox River Wisconsin	2.29 1.71 1.45
1983	Biochemical oxygen demand	Willamette River in Oregan	1.12 1.19
		Delaware Estuary in Penn., Delaware and New Jersey	3.00 2.92
		Upper Hudson River in New York	1.54 1.62
		Mohawk River in NY	1.22

[a]For each river, the various rations correspond to different dissolved oxygen targets.
Source: Tietenberg (1985)

A costly feature of the water quality program has been the Safe Drinking Water Act, first passed in 1974. This act was intended to protect human health by guaranteeing safe public water supplies, but no comparison of its likely benefits and the necessary intake water treatment costs was used in setting the stringent standards. Intake system costs have risen sharply as a result of these standards, and EPA estimates that potable water and related sewage costs for the typical household will increase by 50 percent by 2000 as a result (*U.S. Water News*, 1991).

Several studies have concluded that the total costs of the water quality program outweigh the total benefits and that, in many areas, marginal costs exceed marginal benefits. For 1985, annual benefits were estimated at $14 billion with a possible range from $5.7 billion to $27.7 billion, while estimated average annual costs from 1979 to 1988 were $23.2 billion (Freeman, 1978). The benefit estimates, however, fail to include some important values, such as option and existence values,that might increase the benefit-to-cost ratio. Furthermore, the conclusion may be true for the United States as a whole, but it does not imply that water quality management is not paying its way in some regions.

If the current U. S. system is so costly, why does it persist? The literature suggests the following reasons:

- Lawyers write the rules, and they are trained to believe in regulation and punishment;
- Legislators appear to believe that an enforced system of clearly stated rules is more reliable and more equitable than are systems based on economic motivation;
- Some environmental groups resist economic instruments that treat the environment like property;
- Established firms like the biases against new firms that must meet higher pollution standards;
- The present value of costs to a firm may be lower under the present system (for example, BAT equipment plus operating costs) than under charges (involving equipment plus operat-ing costs plus charges) or tradable permits (equipment plus operating costs plus possible purchase of permits) (Tietenberg, 1988).

Conversely, why are alternative policies avoided, especially the economic instruments of taxes and tradable permits? The literature again suggests that both authorities and polluters fear the effects of untried systems, especially taxes, as well as the high transaction costs in discharge-trading systems. Administrators and legislators also fear the loss of control, and there is an uninformed but widespread feeling that the current "command-and-control system" works well.

Some of these points are valid caveats about the use of alternative economic incentive systems. For example, because only crude estimates can be made beforehand of the aggregate reduction in pollution that would take place in response to a particular level of effluent tax, a costly trial-and-error process might have to be used. Tradable discharge permits might lead to local pollution "hot spots" and the manipulation of permits to control the product market. Nonetheless, nearly all studies that have addressed the present U. S. system have concluded that a basic shift to economic incentive-based systems is the best path to follow. The most prominent examples of such studies are the "Project 88" studies (Stavins, 1991). sponsored by former Senator Timothy E. Wirth (D-Colo.) and the late Senator John Heinz (R-Penn.).

Monitoring and Enforcement

When one assesses the monitoring and enforcement actions undertaken by the states and EPA, it quickly becomes clear that emphasis has been on installation of equipment with a presumption of appropriate operation, on initial compliance, and on self-monitoring. Audits of plants to estimate air and water waste generation have been infrequent and often involve only a review of company-provided records with no direct observations of air and water emissions. Plant audits often have been announced in advance because companies have obtained court injunctions against random visits by authorities (Russell, 1990). Self-reporting has uncovered few violations of standards that were not uncovered through other means (Russell, 1986).

The Federal Water Pollution Control Act Amendments of 1972 require detailed self-monitoring and reporting procedures for all major dischargers. Penalties are prescribed for intentional failures to carry out the required operations. Because reporting accidental spills in a timely fashion is critical, EPA has been searching for a punishment-reward structure that will not discourage reporting but, at the same time, will not encourage careless management.

EPA studies of compliance in the water program during the late 1970s indicated that 77 percent of the major municipal secondary treatment plants were in noncompliance to some degree, and 53 percent had violations classified as serious or significant (Wasserman, 1984). All enforcement agencies have been slow to take enforcement actions against municipal governments. Two GAO studies of "significant violations" of water discharge permits from 1978 through 1979 and 1980 through 1982 indicated violations by 27 percent of the municipalities sampled in 1978 and 1979, 32 percent of the municipalities sampled from 1980 through 1982, and 16 percent of the industries sampled from 1980 through 1982 (U.S. General Accounting, 1983).

Adequate monitoring of both ambient quality and discharges is necessary for a successful program, and penalties upon violation must be significant. The U. S. program has suffered from inadequate monitoring and halfhearted enforcement. Moreover, the present system does not encourage agency policy makers "to make the large investments in monitoring and personnel that are required to make the tedious and unending work of credible enforcement a bureaucratic reality" (Ackerman, 1985). Today's electronic age should make it possible to monitor many sources inexpensively.

Another tool is citizen enforcement of regulations. Since 1970, all of the major environmental laws—the Clean Air Act, Toxic Substances Control Act, Surface Mining Control and Reclamation Act, and Safe Drinking Water Act—have allowed citizen groups to enforce through the federal courts the nondiscretionary duties imposed on federal agencies.

The Benefits of Improved Water Quality and Quality/Quantity Coordination

While past water quality programs have proved to be unnecessarily costly, geographically inflexible (same standards everywhere), and inadequately enforced, there are large benefits that can be enjoyed through improved water quality. An example is found in the water quality of the Colorado River—a river that has suffered increasing levels of total dissolved solids (TDS) from increased Upper Basin agricultural applications and return flows. The ten-year average TDS level, measured at Hoover, Parker and Imperial Dams for the period 1976-1985, was about 700 ppm. A study prepared for the Bureau of Reclamation (U.S. Bureau of Reclamation, 1988) estimated that the annual damages attributable to the rise in TDS from an earlier level of 500 to the more recent 700 ppm amount to $311 million dollars. The breakdown is shown in Table 2.

Howe and Young (1978) estimated that inflows of about 635,400 tons of TDS could be saved economically each year in the State of Colorado alone by taking steps to improve on-farm practices, modify cropping patterns, reduce point sources, and line irrigation canals. Table 3 shows the salinity reduction steps, the estimated salinity reductions, and the estimated costs per ton of TDS reduction.

Using the $311 million estimates of damages associated with the 500 to 700 ppm increase in TDS, one gets an average damage figure of $1.5 million per ppm of change in TDS. Since it takes a 10,000 ton reduction in salt inputs in the Upper Basin to cause a 1 ppm reduction in TDS concentration in the Lower Basin (Maletic, 1974), the benefit per ton of reduced salt input is approximately $150 per ton.

Table 2
Annual Damages from TDS in the Lower Basin of the Colorado River

Total Annual [a] Damages 10-year average	(thousands of 1988 dollars)
Agriculture	$112,000
Household	156,114
Utility	3,236
Industry	6,115
Policy-related	32,550
Total damages	$310,815

[a]Measured from a base of 500 ppm
Source: U.S. Bureau of Reclamation (1988).

Table 3
Potential TDS Reduction Activities in Colorado and Associated Costs

Activity[a]	Tons Saved per Year	Estimated cost/ton
On-farm practices	93,500	$-4.10[b]
Paradox Valley Project	153,000	9.70
Modified Cropping Patterns I	18,300	11.00
Grand Valley Acreage Reduction	88,000	13.80
Uncompaghre Valley Acreage Reduction	102,000	14.00
Modified Cropping Patterns II	10,600	21.60
Lining Grand Valley Canals	170,000	28.50
Total tons per year	635,000	

[a] For detailed descriptions, see Utah Water Research Laboratory (1978)
[b] The estimated negative cost shows that these on-farm practices would increase farm net income independent of any TDS saving.
Source: Utah Water Research Laboratory, 1978, p.35, Table 33.

Comparing that benefit per ton to the costs per ton in Table 3 (or even doubling them for inflation since 1978), it is clear that all these steps would be justified under a rational salinity control plan.

Skogerboe and Walker (1972) estimated that the average salt addition to the Colorado River per acre of irrigated land in the Grand Valley is 10 tons per year. Thus, each acre creates downstream costs (negative externalities) of approximately $1,500 per year. If Grand Valley agriculture had to compensate for these costs, there would be no agriculture in the Grand Valley.

The U. S.-Mexico agreement on Colorado River quality, struck by Presidents Nixon and Echeverria in the early 1970s, requires the U. S. to maintain salinity at the Mexican border at just over the level at Imperial Dam. This currently requires a reduction of about one million tons of TDS per year. It is quite clear that all of the steps listed in Table 3 in Colorado are prime components of any rational approach to this reduction. However, the Bureau of Reclamation has built a $500 million reverse-osmosis plant at Yuma, Arizona to accomplish the reduction (*U.S. Water News*, 1990). If this $500 million is amortized at 5% and if the $25 million annual operating costs are added, the annual costs of this approach amount to $50 million, implying a cost of at least $50 per ton of TDS removed. The load factor on the plant is, however, expected to be low because of improving drainage water quality from the Wellton-Mohawk Project. The cost per ton removed will then be much higher than $50.

This is an example of the irrationality of not coordinating water *quantity* (supply) planning with water *quality* planning. The gross TDS loadings in the Colorado River that caused Mexico to press for a water quality agreement were caused by the initiation of the Wellton-Mohawk Project which washed ancient brines out of the underlying aquifers (Oyarzabal-Tamargo, et al., 1978). It was estimated that the entire irrigated area of the Project could have been bought out for a fraction of the construction cost of the desalting plant.

Howe and Ahrens (1988) have estimated the instream and Lower Basin benefits that would be generated per acre-foot of reduced consumptive use in the Upper Basin. Salinity damages averted are an important component of total benefits as shown in Table 4.

This table brings out the importance of locational differences in setting water policies. Water use in the Grand Valley is responsible for more than seven times the salinity damages of other subbasins because of the heavily saline return flow mentioned earlier. Water use in The Gunnison Valley results in twice the electric energy loss of other subbasins because of the Aspinal (electric generating) Unit on that river. Economically efficient water policies including water quality, must be sensitive to local conditions and system-wide implications.

The benefits mentioned thus far have not included one of the most important benefits from improved water quality—recreational benefits. Greenley, Walsh and Young (1982) estimated recreational values associated with a hypothetical improvement in water quality from degraded to pristine conditions in the South Platte River Basin of Colorado. Population samples were drawn from the town of Fort Collins, The City of Denver and from the remaining parts of the South Platte River Basin. Table 5 presents the annual willingness-to-pay per household for the hypothesized improvement.

While the scenario of water quality change described to the respondent households was somewhat extreme (from waters degraded by mining wastes to pristine condition), the figures indicate a substantial concern with recreational water quality.

The Greenley, Walsh and Young study also attempted to measure other *non-use* values associated with the hypothetical water quality change. "Option value" refers to a household's willingness-to-pay to guarantee the higher level of water quality on the chance that the individual might someday use the river for recreational or aesthetic purposes.

Table 4
Instream Values per Acre-foot of Reduced Consumptive Use in the Upper Basin of The Colorado River

Subbasin	Water Opportunity Cost in LB	Salinity Damages Averted	Electric Energy Value Foregone at 44 mills per/kwh	Total
		(dollars per acre-foot)		
Green River	$30	$38	$46	$114
Yampa, White, Dolores, San Juan, Lower Main Stem	30	38	31	99
Gunnison	30	38	72	140
Grand Valley	30	280	31	341

Table 5. Household Average Annual Willingness-to-Pay Additional Water Fees for Improved Water Quality in Relation to Recreational Use, South Platte Basin, Colorado

(1981 dollars)

Denver Metro Area	$22.30
Fort Collins	$36.48
Other South Platte Basin	$26.18

"Existence value" is represented by a household's willingness-to-pay for preservation of the higher water quality under circumstances in which the individual anticipates never actually using or seeing the river. "Bequest value" is represented by a household's willingness-to-pay to guarantee the higher quality water for future generations. While the nature of these benefits is still being argued, it is clear that non-use values are important to people. Table 6 presents a summary of the estimated aggregate annual values imputed to improved water quality by the occupants of the South Platte region of Colorado.

The most inclusive nationwide estimates of benefits from water quality improvement are those of Mitchell and Carson (1984) for a nationwide improvement from the water quality conditions existing in the early 1980s to EPA's "swimmable" conditions. The estimates were made from a nationwide survey that was carefully crafted to reduce possible biases and to reflect regional differences. The range of aggregate annual benefits of moving from early 1980s actual conditions to "swimmable" conditions was $17 billion to $36 billion. A 1982 estimate of annual national expenditures on water pollution control was $22 billion (Lyon & Scott, 1993), and so it remains unsettled whether or not aggregate benefits exceed total national costs. What *is* clear is that water quality improvement yields very large benefits and that, in at least some regional and local situations, economically designed programs of water quality improvement can yield substantial net benefits.

Table 6. Annual Values of Water Quality in the South Platte River Basin, Colorado

(thousands of 1981 dollars)

	Denver Metropolitan Area	Fort Collins	South Platte River Basin
Option Value:	$3,519	$ 337	$6,375
Existence Value:	4,796	196	6,780
Bequest Value:	4,086	146	5,547
Recreational Value:	9,287	729	10,903
Total Preservation & Recreational Value	$21,688	1,403	29,605

Source: Greenley, Douglas A. Richard G. Walsh and Robert A. Young, 1982 *Economic Benefits of Improved Water Quality: Public Perceptions of Option and Preservation Values*. Studies in Water Policy and Management, No. 3, Boulder, CO: Westview Press, Table 5.3, p. 76.

Benefits and Costs of Future Extensions of the Water Quality Program Under the Clean Water Act

Randolph M. Lyon (Office of Management and Budget) and Scott Farrow (formerly with the Council on Environmental Quality) (1993) have made estimates of the benefits and costs of Clean Water Act programs that are currently planned. Their analysis indicates that annual incremental program costs are likely to exceed incremental program benefits by $8 billion or more. Their estimates of incremental annual benefits, derived largely from an updating of the Mitchell and Carson study referenced earlier, are $5 billion, while incremental amortized capital and operating costs for the states' expressed "needs" for municipal treatment plants come to roughly $13 billion.

They clearly show that non-point sources should be focused on, rather than point sources. They show that non-point source (NPS) pollution is not only more pervasive but also noticeably cheaper to control. Table 7 gives some of their estimates of costs of reducing agricultural pollution in the forms of soil erosion and phosphorus leaching. The negative figures indicate the likelihood that those steps would yield net benefits to farm income independent of environmental considerations.

The Lyon-Farrow study also shows the tremendous variability of projected annual net benefits, state-by-state. Table 8 presents their calculations for a national scenario in which water quality is improved from "boatable" to "fishable" and in which extensive NPS controls are applied to all cropland—the cropland controls also substituting for 50 percent of currently projected point source controls. The results show only 17 states with estimated benefits in excess of costs—emphasizing once again the need to tailor water quality programs to the conditions found in the various states.

Conclusions Regarding Needed Changes in the Water Quality Act

The data presented in preceding sections speak for themselves in identifying needed changes in the Clean Water Act. First, it is essential to coordinate water quantity (supply) planning with water quality planning. The ridiculousness of building a desalting plant to reduce Colorado

Table 7. Cost Effectiveness of Agricultural Management Practices

Practice	Soil Loss		Phosphorus *		Annual Cost
	Percent Reduction	Average Annual Cost ($/ton)	Percent Reduction	Average Annual Cost ($/lb)	($/acre)
Conservation Tillage					
Low till	30-60	0-27.50	25-50	0-198	(3)-(7.50)
No till	60-90	0-11.10	50-80	0- 80	(5)-(15)
Contouring	40-80	0.36-4.79	35-75	0.77-32.86	3.5-8
Terraces	50-90	3.63-43.6	50-75	8.72-261.6	10.2-120.6
Grassed Waterways	60-80	0.29-2.61	40-50	0.94-23.5	2.7-6.7
Sediment Basins	60-95	2.77-29.2	25-50	10.5-420	26.3-78.8

* In addition, EPA reports nitrogen reductions of 50-80 percent for conservation tillage, and up to 30 percent for grassed waterways and sediment retention.

Source: Lyon and Farrow, 1992, Table 3

Table 8 Scenario E1 Benefits and Costs.

State	Benefits ($ Mil.)	Cost of EPA Needs Annual Capital & O&M ($ Mil.)	Cropland Costs ($ Mil.)	Total Cost ($ Mil.)	Benefits/ Cost	Benefits less Cost ($ Mil.)	Benefits per Household ($)	Costs per Household ($)	Benefits less Cost per Household ($)
Alabama	81	101	23	78	1.04	3	54	52	2
Alaska	13	20	0	20	0.64	−7	72	112	−40
Arizona	64	110	6	104	0.62	−40	50	81	−31
Arkansas	38	43	41	32	1.16	5	42	36	6
California	678	1,093	53	1,041	0.65	−363	66	101	−35
Colorado	68	25	53	19	3.66	50	54	15	39
Connecticut	89	262	1	251	0.34	−172	74	217	−143
Delaware	16	11	3	8	1.97	8	64	32	31
Dis. of Col.	15	59	0	59	0.26	−44	61	237	−176
Florida	312	819	18	801	0.39	−489	63	163	−99
Georgia	138	123	33	92	1.50	46	59	40	20
Hawaii	22	42	2	40	0.55	−18	62	114	−52
Idaho	15	9	32	7	2.22	8	43	19	23
Illinois	227	522	124	398	0.57	−171	53	92	−40
Indiana	99	307	69	239	0.42	−140	48	115	−67
Iowa	52	73	132	55	0.96	−2	48	50	−2
Kansas	48	98	146	74	0.65	−26	50	77	−27
Kentucky	59	233	30	204	0.29	−145	43	147	−105
Louisiana	85	181	32	148	0.57	−64	55	95	−41
Maine	25	48	5	43	0.59	−17	55	93	−38
Maryland	118	127	9	118	1.00	−0	70	70	−0
Mass.	151	1,133	1	1,132	0.13	−981	68	510	−442
Michigan	173	611	47	564	0.31	−391	51	166	−115
Minnesota	84	92	115	69	1.23	16	52	42	10
Mississippi	46	82	37	61	0.74	−16	50	67	−17
Missouri	96	145	75	109	0.88	−13	49	55	−7
Montana	13	6	86	5	2.75	8	43	16	28
Nebraska	31	20	101	15	2.08	16	50	24	26
Nevada	22	20	4	15	1.40	6	52	37	15
N. Hampshire	26	139	1	138	0.19	−112	65	343	−278
New Jersey	199	657	4	653	0.31	−454	70	230	−160
New Mexico	23	16	12	12	1.89	11	43	23	20
New York	443	2,443	30	2,413	0.18	−1,970	65	355	−290
N. Carolina	139	240	33	207	0.67	−67	57	85	−28
North Dakota	12	3	135	2	4.97	9	46	9	37
Ohio	202	625	62	563	0.36	−361	49	137	−88
Oklahoma	58	55	58	41	1.40	17	47	33	13
Oregon	64	204	22	182	0.35	−117	58	165	−106
Pennsylvania	220	292	29	263	0.84	−43	49	58	−10
Rhode Island	23	74	0	74	0.31	−51	62	199	−137
S. Carolina	67	56	18	42	1.58	25	55	35	20
South Dakota	11	12	85	9	1.29	3	42	33	10
Tennessee	84	166	26	140	0.60	−56	45	76	−30
Texas	362	687	167	521	0.69	−159	60	87	−26
Utah	22	58	10	48	0.46	−26	42	91	−49
Vermont	10	43	3	40	0.24	−30	46	190	−143
Virginia	146	150	17	133	1.10	13	66	60	6
Washington	113	435	39	396	0.28	−284	62	218	−156
West Virg.	29	167	5	162	0.18	−133	41	228	−187
Wisconsin	89	164	57	123	0.72	−34	49	68	−19
Wyoming	8	1	13	1	8.91	7	47	5	42
TOTAL	5,228	13,105	2,103	11,974	0.44	−6,747	57	131	−74

Source: Lyon and Farrow, 1993, Table E1

River TDS when the responsible irrigation projects should never have been built in the first place is evident. Another case, not mentioned earlier, is represented by the San Joaquin Valley Drainage Project (National Research Council, 1989) —a project designed to deal with toxic drainage waters generated by irrigated acreage that should not have been developed and which continues to apply far too much water because of highly subsidized irrigation water charges. One negative result among several has been the Kesterson Reservoir tragedy—the poisoning of a wildlife refuge with selenium.

A major problem throughout the western U. S. is the underpricing of irrigation water. The Congressional Budget Office estimated (Congressional Budget Office, 1983) that Bureau of Reclamation irrigation projects repay only 18 percent of their total cost to the Federal Government. This underpricing stimulates application of excessive water which then generates excessive deep percolation, dissolution of salts and toxic compounds in the subsoil, and heavily polluted return flows. The National Irrigation Water Quality Program of the U. S. Department of the Interior has conducted reconnaissance-level evaluations at more than 20 project sites and has found major problems at several sites other than Kesterson.

The need to tailor ambient water quality standards and compliance programs to local and state conditions was made obvious by the data in Table 8. Some states present benefit and cost conditions that make more stringent water quality standards highly beneficial while other states may not warrant further improvements. Economic efficiency ideally requires that ambient standards be set at a level for which marginal benefits equal the marginal costs of achieving that standard, *plus* the selection of a compliance program that approximates the minimum cost of attaining that standard. These principles have been largely ignored in past clean water programs.

The achievement of least cost will require much more emphasis on nonpoint sources (Table 7). Point source pollution has been constrained to an extent that marginal costs of further control are, on average, quite high (e.g. tertiary treatment for municipalities). Nonpoint sources pose a range of different problems in measuring pollution rates, linking pollution to measurable inputs, etc., but the cost differences are now great enough to warrant substantial efforts to solve these problems.

It is time to place more reliance on the economic tools of water quality control—effluent taxes and tradable discharge permits. Both seem well adapted to river basin water quality management when combined with effluent standards to prevent "hot spots" along the river. Brown and Johnson (1984) reported the beginnings of such a program in Germany. Taxes, when set at the appropriate level, signal to the polluter the external damages being imposed, and they always motivate a continuing search for lower cost ways of reducing pollution. Tradable discharge permits have found wide application in the air pollution area where uniform mixing may be more realistic, but there must be many potential applications in the water quality area.

Finally, it is again time to consider the re-establishment of river basin commissions to coordinate federal and state policies that affect water quality. The Delaware and Potomac River Basin Commissions are the prime examples of successful *interstate* coordination of water supply, water quality and flood control. The Ohio River Sanitation Commission (ORSANCO) (Cleary, 1967) is another excellent example. Under the Water Resources Planning Act of 1965, several interstate river basin commissions were established, including the New England, Great Lakes, Upper Mississippi, and Ohio River Commissions. Unhappily, these commissions were extremely limited in power by the legislative requirement of unanimous agreement on all decisions—all member states plus the Corps of Engineers and the Bureau of Reclamation. It is time to reconsider a bolder version of these institutions.

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